It's Mud! Sediment Size and Total Organic Content Analysis of Bellingham Bay

Aaron Watkins, Ellen Pak, and Victoria Sims; Mentor - Julie Masura

PSEMP

DEPARTMENT OF ECOLOGY State of Washington

UNIVERSITY of WASHINGTON TACOMA

Introduction

This work is part of the continuing research done by undergraduate researchers at the University of Washington Tacoma, utilizing sediment samples from the Puget Sound Ecosystem Monitoring Program (PSEMP) and the Washington State Department of Ecology Marine Sediment Monitoring Team. The PSEMP urban bays program surveys one of six bays quinquennially, with Bellingham Bay surveyed for 2024. Our research focused on the particle size analysis (PSA) of sediments and the total organic content (TOC) contained within the sediments for Bellingham Bay. TOC and PSA in other studies have also found an inverse relationship between the two variables (Godbold and Sloan 2009; Shamurailatpam et al. 2023; Voltz et al. 2021; Yuan et al. 2020).

Figure 1. Members of the Washington State Department of Ecology Marine Sediment Monitoring Team collecting samples in the Salish Sea (WADOE 2018).

Results

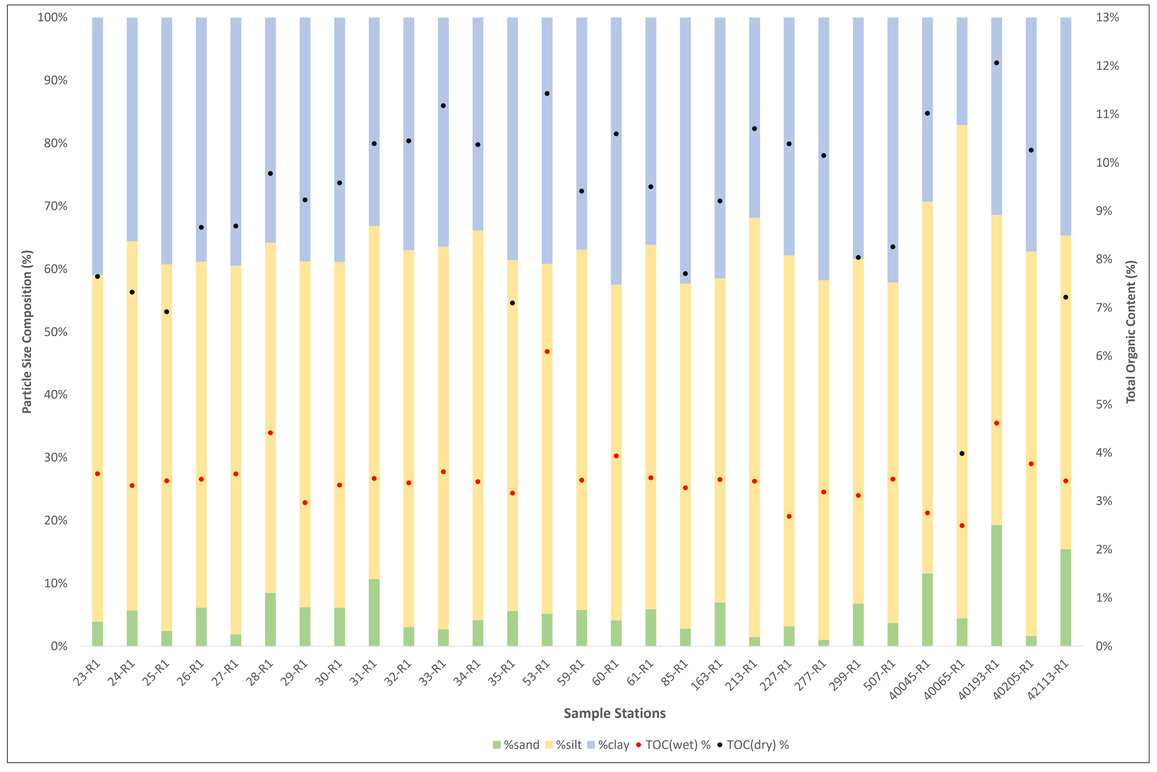

Figure 4 (Left). Comparison of TOC and PSA by sample station. Results showed the grain-size distribution averaged 6% sand, 57% silt, and 37% clay for the 29 stations. TOC averaged to 3.50% carbon (wet mass) and 9.21% carbon (dry mass).

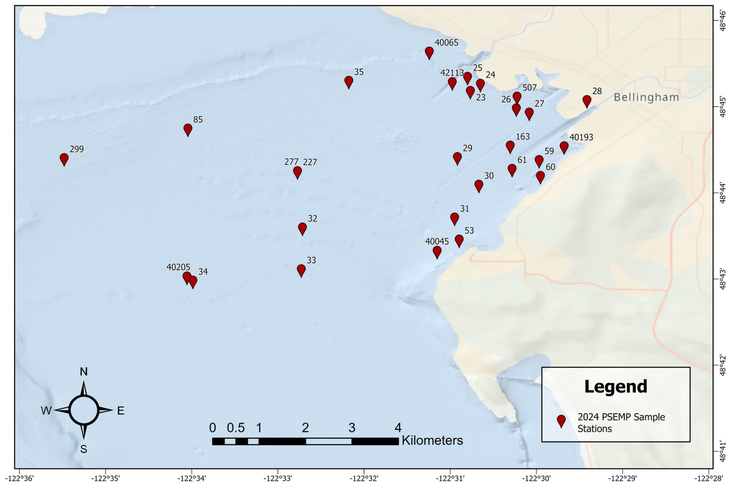

Figure 5 (Above). Twenty-nine sampling stations located in Bellingham Bay, WA.

Purpose of Study

Analyzing TOC and grain size allows us to better understand any relationships that exist between the two variables within urban bays in Washington state. Temporal trends between 2024, 2017, and 2010 data can be used to identify changing distributions of sediments and carbon. Additionally, relationships between TOC and PSA allows us to understand current and possible human impacts on the area through carbon additions, as nutrients, and climate change.

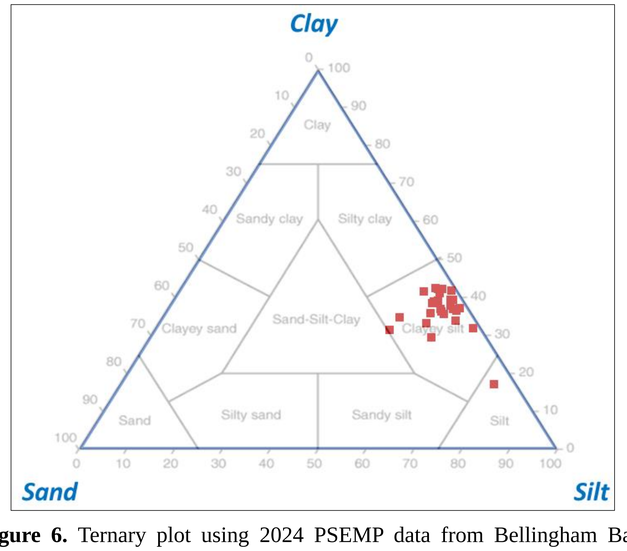

Figure 6. Ternary plot using 2024 PSEMP data from Bellingham Bay. Grain size classifications is based on the modified Udden-Wentworth scale (1922) overlaid on the Shepard (1954) classification system.

Methods

Particle Size Analysis (PSA)

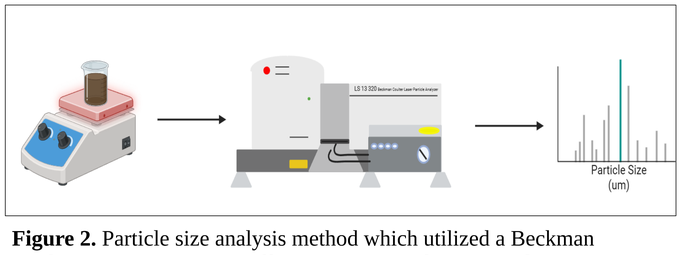

Figure 2. Particle size analysis method which utilized a Beckman Coulter LS 13 320 Laser Diffractometer Particle Size Analyzer to create sediment size histograms showing the distribution of sediments by grain size (Created with BioRender by Aaron Watkins 2025).

Total Organic Content (TOC)

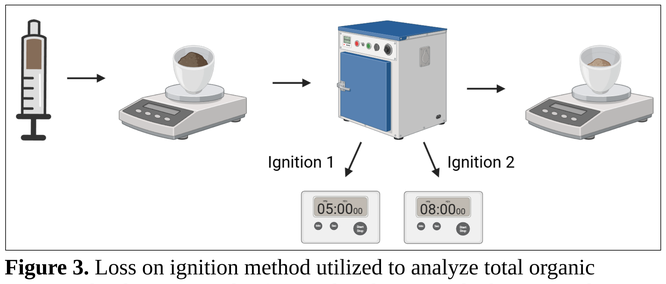

Figure 3. Loss on ignition method utilized to analyze total organic content of sediment samples (Created with BioRender by Kat Barlow 2025).

Previous Work

Previous work in Bellingham Bay indicates that sediment composition was approximately 20% sand, 55% silt, and 25% clay in 2010, and approximately 10% sand, 55% silt, and 30% clay in 2017 (WADOE 2025). TOC wet ranged from 0.5 – 3.5% usually within the bay minus outlier hotspots from anthropogenic nutrient loading (WADOE 2025).

Research Significance

- Bellingham Bay is an important area of study due to frequent agriculture and petroleum runoff.
- Researchers found that smaller particle sizes had the highest total organic carbon percentages (Pandion et al. 2022).
- Low energy levels associated with depositional environments and finer particle sizes allows for organic content to persist in aquatic systems, increasing nutrient levels and as a result, algae levels.
- Further research is needed to determine the true significance between the variables.

References